

## **NO BREAK ELECTRIC POWER TRANSFER SYSTEM**

### **BACKGROUND OF THE INVENTION**

[0001] This invention generally relates to a no break power transfer system. More particularly, this invention relates to ensuring that there is an appropriate frequency match when transferring power between different supplies in a no break power transfer system.

[0002] There are various known arrangements where a secondary or back-up power supply is used in the event of a main power supply failure. There are other situations where auxiliary or back-up power supplies are strategically used on a temporary basis even though the main power supply may be completely functional.

[0003] One example situation where multiple power supplies are utilized is on a modern aircraft. There typically is a main power supply that is sometimes referred to as a main engine generator. An auxiliary power unit (APU) is used in place of the main power supply for various reasons known in the art.

[0004] For a successful switch between power supplies without interrupting power to the electrical component, a so-called no break power transfer is required. This typically involves simultaneously coupling both power supplies to the load and then disconnecting a selected one of the power supplies. The output of the power supplies typically matches so there is no problem when they are both coupled with the load and there is no discernable break in power at the load.

[0005] Traditionally, the auxiliary power unit and the main power supply were set to meet appropriate needs of the aircraft electrical systems. More recently, however, it has been increasingly proposed to use variable frequency alternating

current electrical bus networks in place of traditional constant frequency systems. The variable frequencies that may be used introduce further complexities to achieve a successful no break power transfer. This invention addresses the need for ensuring that an appropriate frequency match occurs during a no break power transfer.

### **SUMMARY OF THE INVENTION**

[0006] In general terms, this invention is a no break power transfer system that ensures that there is an appropriate frequency match associated with the outputs of multiple power supplies during a no break power transfer.

[0007] One system designed according to this invention includes a main power supply that is selectively coupled to a load. An auxiliary power unit is selectively coupled to the load. A frequency adjuster is between the auxiliary power unit and the load for selectively controlling the frequency of the power available from the load from the auxiliary power unit. The frequency adjuster ensures that there is a frequency match between the alternate supplies to the load during a no break power transfer.

[0008] In one example, the frequency adjuster includes a controller that monitors the frequencies on the supply lines to the load associated with the different power supplies. The controller operates an inverter that controls the frequency of the power available from the auxiliary power unit.

[0009] In one example, the inverter modifies the frequency of the power received from the auxiliary power unit as needed when the power transfer is made in either direction between the main power supply and the auxiliary power unit.

**[0010]** The various features and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the currently preferred embodiment. The drawing that accompanies the detailed description can be briefly described as follows.

### **BRIEF DESCRIPTION OF THE DRAWING**

**[0011]** Figure 1 schematically illustrates a no break power transfer system designed according to this invention.

### **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

**[0012]** The figure schematically shows a no break power transfer system 20. An electrical network 22 represents a load onboard an aircraft that includes various electrically powered components. In one example, the electrical network 22 includes a variable frequency electrical bus network. A main power supply 24 provides power along a supply line 26 to the electrical network 22. The main power supply 24 in one example is an engine generator on the aircraft.

**[0013]** The electrical network 22 often requires constant power supply to maintain appropriate operation of the various components that must receive power. An auxiliary power unit (APU) 28 includes a generator 30 and a source of power 32 such as an engine. The source 32 is mechanically coupled at 34 with the generator 30 in a conventional manner. The output from the generator 30 on the line 36 is an alternating current (AC) output, whose frequency depends upon the speed of operation, for example, of the generator 30.

**[0014]** A rectifier 38 converts the AC output of the generator 30 to a direct current (DC) output at 40. An inverter 42 includes electronic components suitable for receiving the DC output of the rectifier 38 and providing an AC output on the line 44 that is supplied to the electrical network 22. Those skilled in the art who have the benefit of this description will be able to select or design an inverter having conventional switching, solid state devices or both to meet the needs of their particular situation. In the illustrated example, a controller 46 controls the operation of the inverter 42 to achieve a desired AC output on the supply line 44. In this example, the rectifier 38, inverter 42 and controller 46 are all part of a frequency adjuster 48.

**[0015]** Because the electrical network 22 may require variable frequency power, it is possible that power supplied from the main power supply 24 is of a different frequency than that which is normally provided by the APU generator 30. The controller 46 determines when the frequencies of the two power supplies do not match and controls the inverter 42 such that there is a frequency match to achieve a no break power transfer between the power supplies so that power to the network 22 is not interrupted.

**[0016]** In the illustrated example, the controller 46 includes inputs 50 and 52 that provide frequency information regarding the output of the main power supply 24 and the inverter 42, respectively. The controller 46 preferably is programmed to determine when there is a need to change the operation of the inverter 42 so that the output on the line 44 matches that on the line 26. An input 54 to the inverter 42 allows the controller 46 to provide suitable commands for altering the operation of the solid state devices, for example, within the inverter 42 to achieve the designed output

at 44. Given this description, those skilled in the art will be able to program a commercially available microprocessor to meet their particular needs.

[0017] A switch arrangement 60 is responsive to the controller 46 to achieve transferring power between the supplies as needed, provided that the controller 46 confirms that there is a match between the power supply frequencies on the lines 26 and 44. When there is a match, the switching arrangement 60 allows for both power supplies to be simultaneously coupled with the network 22. Then the appropriate supply may be disconnected, completing the no break power transfer.

[0018] The controller 46 is operative to command the inverter 42 to provide a selected output at 44 so that the main power supply 24 can be disconnected and replaced with the APU 28. The controller 46 is also operative to modify the frequency provided by the inverter 42 when a power transfer occurs from the APU 28 to the main power supply 24.

[0019] The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed examples may become apparent to those skilled in the art that do not necessarily depart from the essence of this invention. The scope of legal protection given to this invention can only be determined by studying the following claims.